

IMAGE PROCESSING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

5 This invention relates to an image processing method and apparatus for laying out person images, which have been obtained by photographing a plurality of persons, and forming a layout image, such as a school photo. This invention also relates to a recording medium, on which a program for causing
10 a computer to execute the image processing method has been recorded and from which the computer is capable of reading the program.

Description of the Prior Art

15 Album prints, typically school photos, are formed by laying out person images, which have been obtained by photographing persons, in predetermined layouts, thus obtaining layout images, and printing the layout images. As illustrated in Figure 5, if the person images are merely laid out in a layout image comprising the person images, positions
20 and/or sizes of face patterns of the persons will vary for different person images, and the layout image will become unsightly. Therefore, it may be considered to take photographs such that the positions and/or the sizes of the face patterns of the persons in the photographs may be uniform. However, in
25 cases where photographs of a plurality of persons are taken,

considerable time and labor are required to take the photographs by changing the position of the camera in accordance with the heights of the persons and/or the sizes of the faces of the persons. Also, the position of the camera with respect to the persons varies for different cameramen and different dates of photographing. Accordingly, it is difficult to take the photographs such that the positions and/or the sizes of the face patterns of the persons in all of the photographs may be uniform.

Therefore, in cases where a layout image is to be formed, when operations for printing from sheets of negative film, on which person images have been recorded, are performed, the positions of the sheets of negative film and/or the positions of photosensitive materials have heretofore been adjusted such that the positions and/or the sizes of the face patterns of the persons may be uniform among the images. Alternatively, a layout image has heretofore been formed by laying out person images, which have been obtained by performing a trimming process such that the positions and/or the sizes of the face patterns of the persons may be uniform. As another alternative, a layout image has heretofore been formed by printing person images to a comparatively large size, arraying the prints of the person images such that the positions of the face patterns of the persons may be approximately uniform, and again performing the photographing operation.

However, with the technique for forming a layout image by adjusting the positions of the sheets of negative film and/or the positions of the photosensitive materials and performing the printing operations, and with the technique for forming a layout image by arraying the printed images again performing the photographing operation, the efficiency of the layout image formation and the productivity of the layout images cannot be kept high.

SUMMARY OF THE INVENTION

The primary object of the present invention is to provide an image processing method, wherein a layout image, such as a school photo, is capable of being formed efficiently.

Another object of the present invention is to provide an apparatus for carrying out the image processing method.

The specific object of the present invention is to provide a recording medium, on which a program for causing a computer to execute the image processing method has been recorded and from which the computer is capable of reading the program.

The present invention provides an image processing method for obtaining a layout image signal representing a layout image, in which a plurality of person images are laid out, from a plurality of original image signals, each of the original image signals representing a person image, in which a face pattern of a person is embedded, the method comprising the steps

of:

i) detecting face information from each of the original image signals, the face information representing a position and/or a size of the face pattern of the person in the person image represented by each original image signal,

ii) performing a face pattern normalizing process on each of the original image signals and in accordance with the detected face information, a plurality of normalized image signals being obtained from the face pattern normalizing process, and

iii) laying out a plurality of images, which are represented by the normalized image signals, in a predetermined layout, whereby the layout image signal representing the thus formed layout image is obtained.

The term "face information" as used herein means, for example, the information representing a displacement quantity for transformation of a person image such that the position of the face pattern in the person image may coincide with a position in a predetermined reference image or a predetermined coordinate position. Also, the term "face pattern normalizing process" as used herein means a process for transforming the original image signal with an affine transformation technique, or the like, such that the positions and/or the sizes of the face patterns of the persons may become uniform among the person images.

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The present invention also provides an image processing apparatus for obtaining a layout image signal representing a layout image, in which a plurality of person images are laid out, from a plurality of original image signals, each of the original image signals representing a person image, in which a face pattern of a person is embedded, the apparatus comprising:

i) detection means for detecting face information from each of the original image signals, the face information representing a position and/or a size of the face pattern of the person in the person image represented by each original image signal,

ii) normalization means for performing a face pattern normalizing process on each of the original image signals and in accordance with the detected face information, a plurality of normalized image signals being obtained from the face pattern normalizing process, and

iii) editing means for laying out a plurality of images, which are represented by the normalized image signals, in a predetermined layout, and obtaining the layout image signal representing the thus formed layout image.

The present invention further provides a recording medium, on which a program for causing a computer to execute the image processing method in accordance with the present invention has been recorded and from which the computer is

capable of reading the program.

With the image processing method and apparatus in accordance with the present invention, the face patterns of the persons in the person images are normalized, and the normalized image signals are thereby obtained. The images, which are represented by the normalized image signals, are laid out in the predetermined layout, and the layout image signal representing the thus formed layout image is obtained. Therefore, in the layout image reproduced from the layout image signal, the positions and/or the sizes of the face patterns of the persons become uniform. Accordingly, the layout image, in which the positions and/or the sizes of the face patterns of the persons are uniform, can be formed efficiently. As a result, the productivity of layout images, such as school photos, can be enhanced.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram showing an album printing system, in which an embodiment of the image processing apparatus in accordance with the present invention is employed,

Figure 2 is an explanatory view showing a person image,

Figure 3 is a flow chart showing how the embodiment of the image processing apparatus in accordance with the present invention operates,

Figure 4 is a schematic view showing a layout image,

in which a plurality of person images have been normalized,

Figure 5 is a schematic view showing a layout image,
in which a plurality of person images have not been normalized,
and

5 Figure 6 is a schematic view showing layout images
obtained with a different embodiment of the image processing
apparatus in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 The present invention will hereinbelow be described
in further detail with reference to the accompanying drawings.

15 Figure 1 is a block diagram showing an album printing
system, in which an embodiment of the image processing apparatus
in accordance with the present invention is employed. With
reference to Figure 1, the album printing system comprises
reading means 1 for reading out a plurality of original image
signals S0, S0, ..., each of which represents a person image.
The album printing system also comprises detection means 2 for
detecting face information H from each of the original image
signals S0, S0, ... having been received from the reading means
20 1. The face information H represents a displacement quantity,
which is to be utilized in a face pattern normalizing process
for uniformizing the positions and/or the sizes of face patterns
in the person images. The album printing system further
comprises normalization means 3 for performing affine
25 transformation on each of the original image signals S0, S0, ...

and in accordance with the corresponding face information H,
and thereby obtaining a plurality of normalized image signals
S1, S1, ... representing images, in which the positions and/or
the sizes of the face patterns of the persons have been
5 normalized. The album printing system still further comprises
editing means 4 for laying out the images, which are represented
by the normalized image signals S1, S1, ..., in a predetermined
layout, and obtaining a layout image signal S2 representing
a layout image R, in which the plurality of the person images
10 have been laid out. The album printing system also comprises
a printer 5 for reproducing the layout image R from the layout
image signal S2.

The original image signals S0, S0, ... may be obtained
from a read-out apparatus, such as a scanner, which reads out
15 the person images from negative film or positive film.
Alternatively, the original image signals S0, S0, ... may be
obtained from image sensing operations performed by a digital
camera. The thus obtained original image signals S0, S0, ...
are stored on a storage medium or a storage device. The reading
20 means 1 reads the original image signals S0, S0, ... from the
storage medium or the storage device.

The detection means 2 comprises edge detecting means
6 for detecting edges in the face pattern embedded in the person
image, which is represented by each original image signal S0.
25 The detection means 2 also comprises binarization means 7 for

binarizing the original image signal S_0 , which has been obtained from the edge detection, and obtaining a binary signal S_0' . The detection means 2 further comprises pattern matching means 8. The pattern matching means 8 performs a pattern matching process on the binary signal S_0' and a reference signal G , which represents a predetermined binary reference image. The pattern matching means 8 thus detects at least two points, at which the degree of correlation between the person image and the reference image is highest. Also, the pattern matching means 8 determines displacement quantities, which are to be utilized for transforming a center position having coordinates (x, y) in the face pattern embedded in the person image as illustrated in Figure 2 into a center position having coordinates (x_0, y_0) in the reference image, and uniformizing a size v of the face pattern in the vertical direction and a size h of the face pattern in the horizontal direction. The detection means 2 feeds information, which represents the thus determined displacement quantities, as the face information H into the normalization means 3. The reference image represents a contour image of a face having a predetermined size, which contour image is located such that it may have the center position at the predetermined coordinates (x_0, y_0) .

In accordance with the face information H received from the detection means 2, the normalization means 3 performs affine transformation on the original image signal S_0 and

obtains a normalized image signal S1. The affine transformation is performed with Formula (1) shown below.

$$\begin{pmatrix} x2 \\ y2 \end{pmatrix} = \begin{pmatrix} a & b \\ -b & a \end{pmatrix} \cdot \begin{pmatrix} x1 \\ y1 \end{pmatrix} + \begin{pmatrix} c \\ d \end{pmatrix} \quad (1)$$

in which (x1, y1) represents the coordinate values of the person image before being transformed, and (x2, y2) represents the coordinate values of the person image after being transformed.

With the coordinate transformation performed with Formula (1), all of the image size enlargement or reduction of the person image represented by the original image signal S0, the rotation of the entire person image, and the parallel translation of the person image are achieved simultaneously.

The coefficients a, b, c, and d in Formula (1) are determined in the manner described below. Specifically, Formula (1) can be divided into Formulas (2) and (3) shown below.

$$x2 = ax1 + by1 + c \quad (2)$$

$$y2 = -bx1 + ay1 + d \quad (3)$$

The two points in the person image, which are detected by the pattern matching process as the points having the highest degree of correlation with the reference image, may have coordinates (x11, y11) and coordinates (x12, y12). Also, the two points in the reference image, which correspond to the two points in the person image, may have coordinates (x21, y21) and

coordinates (x22, y22). In such cases, Formulas (4), (5), (6), and (7) shown below obtain.

$$x21=ax11+by11+c \quad (4)$$

$$x22=ax12+by12+c \quad (5)$$

$$y21=-bx11+ay11+d \quad (6)$$

$$y22=-bx12+ay12+d \quad (7)$$

The four coefficients a, b, c, and d can be calculated by solving Formulas (4), (5), (6), and (7).

How this embodiment operates will be described hereinbelow. Figure 3 is a flow chart showing how the embodiment of the image processing apparatus in accordance with the present invention operates.

With reference to Figure 3, firstly, in a step S1, the reading means 1 reads the original image signals S0, S0, ... from the storage medium or the storage device. In a step S2, each of the original image signals S0, S0, ... is fed into the detection means 2. In a step S3, the edge detecting means 6 of the detection means 2 performs a differentiation process, or the like, on the original image signal S0 and detects edges in the person image represented by the original image signal S0. In a step S4, the binarization means 7 performs a binarizing process on the original image signal S0, which has been obtained from the edge detection, the binary signal S0' is obtained from the binarizing process. Thereafter, in a step S5, the pattern matching means 8 calculates the displacement quantities, which

are to be utilized for transforming the center position having the coordinates (x, y) in the face pattern embedded in the person image into the center position having the coordinates (x_0, y_0) in the reference image, and uniformizing the size v of the face pattern in the vertical direction and the size h of the face pattern in the horizontal direction. The information, which represents the calculated displacement quantities, is fed as the face information H into the normalization means 3.

In a step S6, the normalization means 3 calculates the affine transformation coefficients with Formula (1) and in accordance with the face information H , performs the affine transformation on the original image signal S_0 , and obtains the normalized image signal S_1 representing the image, in which the position and/or the size of the face pattern of the person has been normalized. In a step S7, a judgment is made as to whether all of the original image signals S_0, S_0, \dots having been read by the reading means 1 have been or have not been normalized. In cases where it has been judged that all of the original image signals S_0, S_0, \dots have not been normalized, the processes from the step S2 to the step S6 are iterated. In cases where it has been judged that all of the original image signals S_0, S_0, \dots have been normalized, in a step S8, the editing means 4 lays out the images, which are represented by the normalized image signals S_1, S_1, \dots , in a predetermined layout and obtains the layout image signal S_2 representing the

layout image R. Thereafter, in a step S9, the printer 5 prints the layout image R in accordance with the layout image signal S2.

In this manner, with this embodiment, the process for normalizing the face patterns of the persons in the person images is performed on the original image signals S0, S0, ... representing the person images, and the normalized image signals S1, S1, ... are thereby obtained. The images, which are represented by the normalized image signals S1, S1, ..., are laid out in the predetermined layout, and the layout image signal S2 representing the thus formed layout image is obtained. Therefore, as illustrated in Figure 4, in the layout image R reproduced from the layout image signal S2, the positions and/or the sizes of the face patterns of the persons become uniform. Accordingly, the layout image R, in which the positions and/or the sizes of the face patterns of the persons are uniform, can be formed efficiently. As a result, the productivity of layout images R, R, ..., such as school photos, can be enhanced.

In the embodiment described above, the detection means 2 detects at least two points having the highest degree of correlation by performing the pattern matching process and calculates the affine transformation coefficients a, b, c, and d to be utilized for the normalization of the position and/or the size of the face pattern of the person in the person image. In cases where only the position of the face pattern of the

person in the person image is to be compensated for, only one point having the highest correlation may be detected, and the position of the face pattern may be uniformized in accordance with the detected point. In this manner, the normalization of the face pattern can be performed quickly.

Also, in the embodiment described above, the detection means 2 detects the edges in the person image, performs the pattern matching with the reference image, and thereby calculates the displacement quantities.

Alternatively, the displacement quantities may be calculated with a technique described in, for example, Japanese Unexamined Patent Publication No. 6(1994)-67320. Specifically, the person image may be divided into a plurality of regions in accordance with the distributions of the hue and saturation values in the person image, and a face candidate region may be detected. A face region may then be detected in accordance with the shape of a neighboring region, which is located in the vicinity of the face candidate region. Thereafter, the pattern matching process as described above may be performed on the signal representing the face region, and the displacement quantities may thereby be calculated. As another alternative, an ellipse circumscribed about a simply detected face candidate region may be formed, and the displacement quantities with respect to the reference image may be calculated by taking the center point of the ellipse as the center position of the face

pattern having the coordinates (x, y). The face region may be detected with one of various other techniques. For example, the face region may be detected by utilizing neural network techniques described in, for example, Japanese Unexamined Patent Publication Nos. 5(1993)-274438 and 5(1993)-307605.

Further, in the aforesaid embodiment, the layout image R is formed by normalizing the face patterns of a plurality of different persons. Alternatively, as illustrated in Figure 6, an album may be formed by combining a plurality of layout images, each of which comprises a plurality of images of the same person. In such cases, the image processing apparatus in accordance with the present invention can be utilized for normalizing the positions and/or the sizes of the face patterns, which are embedded in the images constituting each layout image.